arranged symmetrically on both sides of the trench. Opposite rail posts are kept vertically equidistant on either side of the trench by an articulated truss able to adjust the trench width. The rail post has on both sides a channel of stepped cross section. Each step constitutes a vertical guide to slide at least one shoring panel. The shoring panels slide between each corresponding guide of adjacent rail posts and, according to the number of the guides, form two or more shoring walls. Thus, the panels slide past each other creating stepped shoring wall from the top to the bottom of the excavation. The outermost and innermost steps of the shoring wall are called respectively outer and inner walls and so the panels. All other panels in between are called intermediate. The connections between rail posts and shoring panels are performed by magnetic forces engendered by magnetic flat bar incorporated in the lateral ends of the panels. For safety purposes partial locking may be used for the outer and inner panels. The intermediate panels slide completely free relative to the rail post. The articulated truss is of scissoring type composed by triangular cells only. The cross members of the truss are pinned at their mi-length allowing their relative rotation in order to adjust several trench widths; their extremities are pinned into vertical members of the truss which slide formlockingly along the rail post. For very deep applications, the vertical members of the truss have lateral guides for sliding additional panels at the bottom of excavation.

It is known to provide shoring devices having vertical rail posts, shoring panels and horizontal spreaders pressing the shoring walls against side wall of the trench. Such shoring devices are called as 'Slide Rail Shoring Systems', so said hereafter.

Previous slide rail shoring systems as disclosed in US Pat. Nos. 3,910,053 and 4,657,442 (Krings), use a rail post having individual formlocking channel connections of 'C' type for sliding the panels. The load developed by the active pressure of the excavation walls is spread on very limited areas of contact between post and panel whereon the stresses are highly concentrated becoming sources of high friction and temperature during the installation and removal of the system. Thus, rough damages are engendered in both rail post and the panel, which strongly limit the application of a such system in pipeline productions, where the installation and removal of the system are effectuated continuously.

The US Pat. Nos. 5,310,289 and 5,503,504 (Hess et al.), disclose a rail post having a

unique channel for a maximum of two shoring walls, created by an outer and by an inner panel. Only the outer panel slides formlockingly within the post; the inner panel is completely free and slides inside the outer panel and the rail posts. The design of inner panel presents a risk of kicking in the trench when adjacent rail posts are not aplomb arising an important safety concern for the worker inside the trench. This phenomenon becomes prominent when the depth of excavation is over 20' deep. On the other hand, shoring of excavations over 16' deep requires to stack and connect together two or more panels, which afterward must be removed at once. Removing, two or more panels at once is a very difficult task and some times impossible to accomplish even when heavy duty equipments are used. Yet another matter relating this design faces the difficulty of removing the inner panel when the deflection of the upper panel is on its way. Also, it should be noted that a slide rail shoring system using unequal types of panels requires much bigger inventory in panels than its counterparts that use interchangeable types of panels.

The US Pat. Nos. 3,950,952 (Krings), 5,310,289 and 5,503,504 (Hess et al) disclose very similar strut frames of rectangular structure whose vertical members are equipped with rollers. These frames are designed to slide vertically between opposite rail posts in order to support the load coming from either side of the shoring walls. From an engineering standpoint a frame composed by a rectangular cell is not a stable structure because allows the deformations without affecting the length of its members. On the other hand, the lower horizontal strut of the frame diminishes the pipe culvert requiring special remedy solutions for the installation of pipes having big diameters or of big box culverts.

BRIEF SUMMARY OF THE INVENTION

Substantially, the intent of present invention is to provide a shoring device of the type described above that reduce the friction and the stresses in the contacts between components, while increases the safety and eases its use in great depths. Pursuing this object and others that will become explicit hereafter, one aspect of the present invention resides on the design of the rail post, which has channels of stepped cross section allowing to create

more than two shoring walls in a single channel without increasing the material expenditure and eliminating the interference between panels as well. Since the vertical guide of the rail post is of stepped cross section, it excludes the contact between rail post and back panel, while the contact area in the front panel is increased. Another new aspect of the invention is the incorporation of magnetic flat bars in the lateral ends of the panels simplifying the connections between rail post and panels reducing therefore the risk for their damage.

The first object of this invention is to present a slide rail system having partially or completely open sliding connections for the panels along the rail post. Also, it is an object of this invention to provide a rail post enabling the slide of two or more panels past each other, without need of their stacking, tremendously extending the shoring depth for a slide rail shoring system. Another object of this invention is to present an articulated truss able to adjust several trench widths, while providing a big pipe culvert and performing additional role than just supporting opposite rail posts, such that sliding additional panels in its vertical members. Also, it is the object of the invention to introduce accessory devices to be used in conjunction with the slide rail shoring system in order to increase the safety and facilitate its installation and removal. It is the final object of this invention to present a slide rail shoring system that practically has not as limit the depth of excavation.

The new features considered as characteristic for the invention are set forth in the appended claims. Other advantages of the invention will be appreciated in view of the following description and drawings.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

FIG. 1 is a sectional view of a trench showing two rail posts and an articulated truss in between.

FIG. 2 is a sectional view taken along the line I-I of the FIG. 1, showing the cross section of the rail post, said linear rail post, having laterally the shoring panels on either side and the top view of the vertical member of the articulated truss.

FIG. 3 is a schematic top fragmentary sectional view of a linear rail post depicting another connection with the articulated truss.

FIG. 4 is a schematic top fragmentary sectional view of a linear rail post according to the invention in FIG. 1, but with three guides for the panels.

FIG. 5 is a schematic top fragmentary sectional view of a linear rail post according to the invention in FIG. 1, but depicting guide channels which are completely open for sliding the panels.

FIG. 6 shows a schematic top fragmentary sectional view of a rail post, said corner rail post, that has guide channels oriented perpendicularly to each other for creating perpendicular shoring walls.

FIG. 7 shows a side view of the articulated truss similar to the one in the FIG 1.

FIG. 8 is a sectional view taken along the line 2-2 of the figure 7, showing the pin connections between cross and vertical members of the truss.

FIG. 9 shows a side view of the articulated truss having a horizontal strut connecting the upper part of the vertical members.

FIG 10 shows a side view of an articulated truss wherein the vertical members have on either side guide channels for sliding additional panels.

FIG. 11 shows a three dimensional view of a shoring panel depicting its main features..

FIG. 12 is a partial three-dimensional view showing the connection of the cutting edge at the bottom of the panel.

FIG. 13 is a three-dimensional view of the lateral end of a panel incorporating magnetic flat bars.

FIG. 14 shows a three-dimensional view of a sliding device fixed on the back of the rail post to slide formlockingly relative to another post.

FIG. 15 shows a frame acting simultaneously on the upper and lower pairs of the rail posts.

FIG. 16 is a three dimensional view of a hammering device to be fixed on the top of a panel for preventing its damage during installation in the ground.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the drawings where like numerals indicate like elements, various embodiments incorporating the new features of the present invention are illustrated. The shoring device has two or more pairs of rail posts spaced from each other along the excavation. FIG. 1, illustrates a pair of rail posts **1A** and **1B**, said linear rail posts, which are located symmetrically on either side of the trench. Each rail post has laterally on either side at least two guides **2** and **3** for sliding large shoring panels between adjacent rail posts. The opposite rail posts **1A** and **1B** are kept vertically equidistant by an articulated truss **16**, which is composed by the cross members **18A** and **18B**, pinned together at their mi-length with the axle pin **19,** and by the vertical members **17A** and **17B**. As shown in FIG. 2, the panel guides **2A** and **3A** are inside a unique channel of stepped cross section shaped by the pieces **8**, **9A**, **10A**, and the angle **11A**. The round bars **14A** and **15A** lock partially the shoring panels **5A** and **6A,** which shape thereby respectively an outer and an inner shoring wall. The front side of the rail post, looking inside the excavation, has a 'C' channel shaped by the pieces **9A**, **9B**, **10A**, **10B** and **13**, wherein slides one vertical member of the articulated truss been horizontally locked by the T shaped piece **20**. The load originated on the excavation wall is transmitted from the panels to the articulated truss through the rail post and the rollers **21A** and **21B** which are supported by the axles **22** and the axle holder **23** located at the extremities of the vertical member **17** of the truss. As shown in the FIG. 3, the channel for sliding connection between the articulated truss and the rail post could be outer to the rail post and made by two angle pieces **26A** and **26B**. As shown in the FIG. 4, the rail post could have laterally intermediate panel guides **4A** and **4B** shaped respectively by the angle pieces **12A** and **12B**. Therefore, an intermediate shoring wall is created by the shoring panels **7A** and **7B**.

FIG. 5 shows a top fragmentary sectional view of a rail post for pit applications, said corner rail post. The steps **11A** and **11B** are within perpendicular plans for sliding the panels **5A** and **5B** shaping adjacent outer shoring walls. Likewise, the steps made by the pieces **9A** and **9B** hold the panels **6A** and **6B** of the inner shoring walls.

In a corner rail post, the round bar **15** (**A** or **B**) is optional because the inner panels **6A** and **6B** block each other due to the load coming from perpendicular directions and the fact that the inner panel are installed after the outer one..

As shown in the FIG. 6 the channels **2A, 3A** and **2B, 3B** for guiding respectively the panels **5A, 6A** and **5B, 6B** in the linear rail post, could be completely open when using magnetic connections. The panels have the same length and mirror each other relative to the piece **13**.

As shown in FIG. 7, the articulated truss **16** has triangular cells only. The cross members **18A** and **18B** are connected to the vertical members **17A** and **17B** via the extension **33**, flanges **34** and the pin connector **30**. The pin connector is fixed in one of the holes **31** by the pin **32**. For the same length of extensions **33,** the width of the truss (so of the trench), could be easily modified by fixing the pin connector from one hole **31** to another one. The articulated truss is manipulated by the lifting holes **36** of the edges **35**. As shown in the FIG. 8, a nut **37** secures the pin **32** of the connector **30**. FIG. 9 shows a horizontal strut **38** used within articulated truss **16**. The strut **38** is connected to the vertical members of the truss via contact flanges **40** and the pin **39**. Yet another type of the articulated truss **16** is shown in the FIG. 10, where the vertical members **17A** and **17B** are extended way below the rollers **21A** and **21B** creating the guides **4A** and **4B** for sliding additional panels in very deep excavations.

As shown in the FIG. 11, the shoring panel has the guides **41** and **42** to slide inside the rail post, lifting plates **47** provided with a hole **48** and a cutting edge **43** fixed at the bottom by the pin or bolt **50**. To prevent damages on the panel, the upper part of it is composed by two square tubes **46A** and **46 B** slightly from each other and a cover plate **45**. The bottom and the top of the panel are identical and it can be used both ways. A thin flat plate **44**, said skin, could be used between lifting plates **47**, which means in the middle part of the panel only, to reinforce and reduce the bending of the panel due to the moment which increase parabolically from zero at its ends to a maximum at the middle. On the other hand, a such skin protect the panel éxactly in the area where the bucket of the excavator is the most active.

The cutting edge **43** shown in the FIG. 12, is pinned or bolted to the panel by the pins **50A** and **50B** via the plates **51A** and **51B** provided with holes respectively **52A** and **52B**.

FIG. 13 illustrates another shoring panel **5** which performs magnetic connection with linear and/or corner rail post by incorporating magnetic flat bars **54** on the sides of the panel guide **41**. To prevent the damages on the magnetic flat bars, two plates **53** are fixed on the guide **41** to support the pressure of contact between post and panel.

As shown in the FIG. 14, a sliding device **55** could be fixed by the bolts **54A** and **54B** on the back side of a rail post **1** when the depth of excavation is great and the need to slide a pair of rail post within another one is needed. The sliding device **55** has a formlocking T shaped piece **53** that goes inside the 'C' channel in front of the other rail post identical to the 'T' shaped piece **20** of the articulated frame in the FIG. 1. As shown in the FIG. 15, the truss supporting the pairs of rail posts acts simultaneously on the upper pair of rail posts, **1A** and **1B**, through the rollers **21A**, **21B** and on the lower pair of rail posts, **1C** and **1D**, via the rollers **21C**, **21D**. The truss could be of articulated type as indicated schematically by the dash-dot line or as a rectangular frame. The FIG. 16 shows another accessory device to be fixed on the top of the panel **5** to prevent damages during the installation of the system. The accessory device is made by welding together the two plates **57** and 58 and can be pinned or bolted by the pin **60** within the hole **48** and **59**.